FRASER RIVER
Estuary Management Program

Waste Management Activity Program
Background Paper

Potential Surface Water Contamination From Miscellaneous Sources In The Fraser River Estuary

December 1990

FRASER RIVER ESTUARY MANAGEMENT PROGRAM

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For the

Waste Management Activity Program

Working Group

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Preface

The Waste Management Activity Program is one of seven activity programs under the Fraser River Estuary Management Program, each responsible for preparing activity plans addressing estuary wide activities. A Recommended Waste Management Activity Plan (Waste Management Activity Program Work Group, 1990), was produced earlier. Discussion papers covering in more detail some areas of concern for waste management in the Fraser River estuary have since been prepared. They include:

- Agricultural Runoff Contamination in the Fraser River Estuary
- Potential Groundwater Contamination in the Fraser River Estuary
- Potential Water Contamination From Miscellaneous Sources, Fraser River Estuary

Each discussion paper contains technical information, management strategies, and action elements required for the management of various waste sources to the estuary. Not all available information may be included, nor may all possible management alternatives be discussed. Further work may be required. The purpose of the discussion papers is to stimulate discussion regarding policy actions for control and management of wastes in the Fraser River estuary.

This Miscellaneous Wastes Discussion Paper is relatively incomplete as all information or management initiatives are not detailed. The agencies mentioned in the respective management section for each waste source should be consulted for more information.

Copies of these reports are available from the Fraser River Estuary Management Program office.

Acknowledgements

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Introduction

While the major sources of contaminants to the Fraser River estuary are from municipal sewage treatment plants, industrial effluents, stormwater discharges, or agricultural discharges, there are a number of other sources which, while generally minor, may result in significant localized impacts. These include sources that are on, in, over, or beside the water: floating homes and water craft, log booms, marine timbers, shipyards, and bridges. Contaminants may also be brought into the estuary from upstream, deposited from the atmosphere, introduced through accidental spills, dumped illegally, or reintroduced to the water column by disturbing contaminated sediments.

This background paper is subdivided into thirteen sections, each considering a source or area of potential contamination. For each, the nature and magnitude of the waste management problem is defined, along with the legislation, programs, and current and recommended best management practices. Action requirements, which may include research, public awareness, or development and implementation of control measures, are then summarized.

Floating Homes, Houseboats, Liveaboards

Nature and Magnitude of the Problem

Floating homes are homes constructed on floats and moored at a specific location. Houseboats are capable of moving under their own power, but are rare in the estuary. Liveaboards are pleasure craft, fishing boats, or other self-powered vessels that are inhabited as living quarters.

Waste management for floating homes is part of a larger regulatory issue. About 150 to 175 floating homes on the Fraser River are illegal as they do not meet municipal zoning requirements or harbor commission leasing regulations. Floating homes may be moored in places that are convenient for their owners, and raw sewage may be discharged over the side. While some marinas service their floating homes with water and sewer connections, they may not be zoned for floating homes. About 50 floating homes are in compliance with all regulations, and have hook-ups to sewer lines or to package secondary treatment plants (table 1). Disposal of liquid household wastes in these cases is not a problem. Concerns regarding illegal floating homes are for discharges of untreated sewage direct to the Fraser River (table 2).

Table 1 MOE MARINA PERMITS

No.	Name	Flow (m^3/day) Permitted	Reported
Main Stem:			
PE0441	Kenrae Enterprises	273	0
Main Arm:			
PE5230	Farrell Estates Ltd	227	6
PE6286	Strata Plan NW-2245	34	nd
PE6375	Riverbank Village	6.8	3
PE8436	Wes Del Marina	21.6	nd

nd no data
(Source: Environmental ProtectionPermit Files)

Table 2
FLOATING HOME LOADINGS, FRASER RIVER ESTUARY

Parameter	Concentration[1] (mg/L)	Amount[2] (kg/yr)
Discharge (m^3/year)		72,562
BOD	250	18,141
Suspended Solids	250	18,141
Ammonia	25	1,814
Fecal coliforms	24[3]	1.7×10^{16}

[1] Assumed similar to Lulu Island STP influent sewage
[2] Based on 175 vessels discharging 1,136 L/day/unit
[3] Most probable number: x 10^6/100 mL

There are about 60 liveaboards in the Fraser River estuary area (Kennett and McPhee, 1988). As liveaboards usually have fewer facilities than floating homes, total discharge and loadings from these vessels is less than one third that of floating homes.

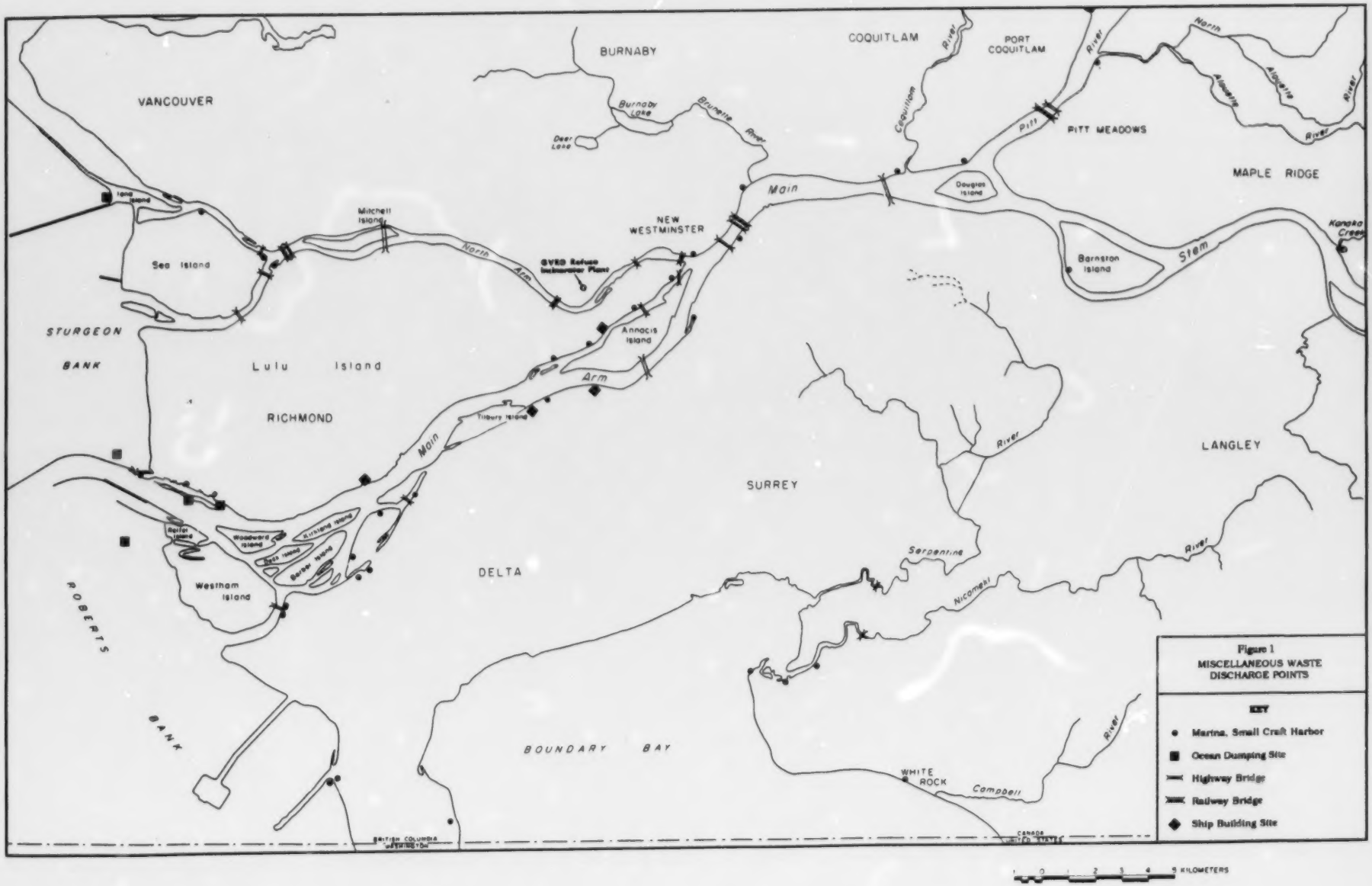
Management

The North Fraser Harbour Commission and the Fraser River Harbour Commission have zoning regulations that control the location of marinas and floating homes. Marina and floating home location and requirements for water and sewer hookups are regulated by municipal bylaw in several municipalities bordering the estuary. The Health Act, administered by the Department of Health through local Health Units and municipalities, addresses sewage discharge from private residences, and allows for regulations. Under the Waste Management Act, all discharges emanating from a single or double unit dwelling have a Class A: municipal type exemption from permit requirements. Commercial operations, such as marinas or floating home colonies, are required to obtain a Waste Management Permit.

Actions Required

Actions required include:

- Enforce regulations. Enact provisions of Waste Management Act , Health Act, and municipal bylaws as required
- Enhance coordination between the provincial ministries of Environment and Health, the harbor commissions, and the municipalities involved


VANCOUVER
BURNABY
COQUITLAM
PORT COQUITLAM
PITT MEADOWS
MAPLE RIDGE
NEW WESTMINSTER
Sea Island
Lulu Island
RICHMOND
STURGEON BANK
SURREY
DELTA
LANGLEY
Westham Island
Annacis Island
Barnston Island
Douglas Island
Tilbury Island
Mitchell Island
Deer Lake
Burnaby Lake
Brunette River
Coquitlam River
Pitt River
North Alouette River
Alouette River
Main
North Arm
Arm
Stem
Kanaka Creek
Serpentine River
Nicomekl River
Campbell River
BOUNDARY BAY
WHITE ROCK
ROBERTS BANK
GVRD Refuse Incinerator Plant
Figure 1
MISCELLANEOUS WASTE DISCHARGE POINTS
KEY
Marina, Small Craft Harbor
Ocean Dumping Site
Highway Bridge
Railway Bridge
Ship Building Site
KILOMETERS

Shipping, Fishing Boats, Pleasure Craft

Nature and Magnitude of the Problem

Water craft on the river include large and small pleasure boats, cruise ships, freighters, tankers, fishing boats, and tug boats. These may or may not have on-board sewage facilities, including toilets and/or holding tanks. Those with installed facilities may discharge directly overboard rather than using on-shore pump-out facilities. Other wastes requiring disposal include bilge waters, ballast waters, and tank or hold wash waters. In addition to waste discharge, hulls are usually treated with anti-fouling paints or compounds. These include organotins such as tributyl-tin (TBT) and copper-based paints which have pesticidal properties and drawbacks: while toxic to the intended organisms, they are also toxic to non-target species, and leach from hulls to concentrate in harbor waters.

The impact of sewage discharge from boats is primarily bacteriological contamination, though oxygen demanding materials are also discharged. Several studies have reported increases in coliform counts in water and shellfish due to the presence of boats. Kay (1982) attempted to correlate bacteriological shellfish contamination, water quality, and vessel counts at a number of boat anchorage sites in the northern Strait of Georgia and the Sunshine Coast area. Coliform counts vary with temperature, turbidity, boat densities, tides, day of the week, season of the year, and number of persons aboard each boat. Water quality may be so variable, or background levels of coliforms from land-based sources so high, that boating-related impacts cannot be measured or are masked (PSWQA, 1986).

Estimates of sewage generated from boats in the estuary depend on the number of on-board sewage facilities, on-shore pump-out facilities, rate of use of pump-out facilities versus discharge overboard, number of boats, volume of usage, estimated by person-days of boating, and amount of sewage generated for each person day. Studies in Puget Sound suggest pump-out facilities there are inadequate to deal with the volume of use required to fulfill the intent of their regulations. The proportion of vessels with marine sanitation devices, and the availability of pump-out facilities, is lower in the Fraser estuary than it is in Puget Sound.

Annually, over 500 freighters enter the Fraser ports, along with the occasional cruise ship. Over 800 fishing boats moor at Steveston, Ladner, Annieville, and other properties, plus another 300 during peak periods. There are over 40 marinas, wharves, docks, or boat launch areas along the Fraser River estuary and Boundary Bay, with over 2,000 berths.

Management

The Canada Shipping Act (RSC 1985 Chap. S-9; RSC 1985 Chap. 6 (3rd Supp.)) applies to all ships in Canadian waters and fishing zones. "Ship" is defined as any vessel, boat, or craft. Regulations may be promulgated that prohibit discharge of any defined pollutant.

The Small Craft Harbours branch of Fisheries and Oceans Canada has jurisdiction over harbors at Steveston and Ladner. Research on recreational fishing effort is also undertaken by Fisheries and Oceans Canada.

The use of TBTs in anti-fouling paints has been restricted. Guidelines are under development by Fisheries and Oceans Canada and Environment Canada.

Actions Required

- A better idea is needed of the numbers of vessels in the estuary, the length of time they are used in the estuary, and the amount of waste generated and its disposal. The number of installed marine sanitation devices and their frequency of use should be investigated along with the adequacy of on-shore pump-out facilities
- Best Management Guidelines for Anti-Fouling Paints should be developed. Monitoring of TBT and copper concentrations near marinas could be considered for inclusion in monitoring programs

Marine Timbers

Nature and Magnitude of the Problem

Marine timbers are wooden water contact structures such as wharf and dock pilings, piles and dolphins used to moor log booms, bridge pilings, river training walls, and other structures. Pressure or thermal impregnation of chemicals into the wood used in these structures is intended to provide long term resistance to attack by fungi, insects and marine borers.

The chemicals predominantly used for wood preservation are creosote, pentachlorophenol, and aqueous formations of arsenic, copper, chromium, or ammonia. Creosote is the most commonly used preservative for water contacting uses. In order to be effective, these compounds are toxic to target species. However, they are also toxic in varying degrees to humans and non-target aquatic organisms. The main problem is that some proportion of the

chemicals do not remain on the treated wood, but leach into the surrounding waters where they can effect non-target species.

Controlled studies have shown that wood preservation enhances the lifetime utility of wood by 5 to 15 times, depending on the wood species, use, and treatment effectiveness (Konasewich and Henning, 1988). Without preservation treatment, timber requirements would be greater, along with costs for maintenance, replacement, and supply.

Almost all marine timbers used in the Fraser River estuary are preserved with creosote, a coal-tar distillate consisting principally of liquid and solid aromatic hydrocarbons, including polyaromatic hydrocarbons (PAHs). Relative compositions of creosote components vary from batch to batch due to differences in the character of the tar and the distillation process, but the PAH content is usually around 50%. Naphthalene and the other low molecular weight PAHs usually predominate.

The low molecular weight PAHs are generally more acutely toxic to aquatic organisms, while most high molecular weight PAHs are carcinogenic. High PAH levels in sediments have been indicted in incidences of tumors and liver lesions in bottom dwelling fish. Creosote treated marine timbers are a suspected source of PAHs to the Fraser River estuary.

There is 1,444 m of timber training structures at Steveston Island and Sapperton, a 430 m timber and steel structure at the New Westminster river trifurcation, 6,588 m of timber and rock structures at the New Westminster trifurcation, Sapperton Island, and Albion Island. All log storage areas in the estuary have dolphins or pilings to which the booms are moored.

Management

The use of creosote can be regulated under the Canadian Environmental Protection Act, the Fisheries Act, the Pest Control Products Act, the Waste Management Act, and the Pesticide Control Act. While there are no regulations for creosote use, guidelines suggest creosote treated wood be completely dry before submergence, thus limiting leaching.

Though there are no water quality criteria or standards specifically for creosote, there are criteria for component compounds, especially benzo(a)pyrene. Limits on benzo(a)pyrene are effective at limiting other PAHs. The limit is usually 0.01 ppb in water and 1 ppb in sediment or fish to protect aquatic organisms (Konasewich and Henning, 1988).

Actions Required

- Continued monitoring to determine the extent of PAH contamination from marine timber preservation

Bridge-Sandblasting and Repainting

Nature and Magnitude of the Problem

There are 20 road or rail bridges over the Fraser River within the estuary, and several more bridges over Fraser River tributaries and the Serpentine, Nicomekl, and Campbell Rivers and their tributaries. Those that are wooden trestle bridges or that rest on wooden pilings are generally preserved with creosote, and are included in the marine timbers section above. The others are steel or concrete structures which require periodic maintenance and repainting.

Bridge-sandblasting and repainting may introduce sand, slag, and paint particles to receiving waters unless this is prevented. These contaminants can cause an impact on aquatic organisms through toxicity, turbidity, clogging of gills, and smothering of benthic vegetation.

Management

A Code of Practice for Bridge Sandblasting has been developed by Fisheries and Oceans Canada and Environment Canada. Guidelines or protocols of practice suggest that sand be clean and not contain slag, that minimum amounts be used, that lead dust be collected, that non-toxic paints be used and overspray minimized, and that seasonal timings be adhered to.

Actions Required

- Follow Code of Practice when bridges are maintained
- Follow-up evaluation of Code compliance and effectiveness

Ship Building, Repair, and Maintenance Facilities

Nature and Magnitude of the Problem

One major and several smaller ship-building, repair, and maintenance facilities are located in the estuary. These include: B.C. Ferries Corp, B.C. Packers Ltd, Progressive Marine Ltd, Purvis Navcon Shipyard Ltd, Rivtow Shipyards, Shore Boat Builders Ltd, Tom-Mac Shipyards Ltd, and Vito Steel Boat and Barge Construction Ltd. These construct, convert, alter,

or repair a variety of ships and barges, frequently in dry dock. Activities include cargo or fuel tank cleaning, abrasive removal of paint, and repainting.

Environmental concerns are centered on the release of metal based blasting abrasives, old paint debris, and spills of waste oil, solvent, and paint. Metal and organic contaminants may accumulate in sediments, and cause biologic toxic response. When dredged, these contaminated sediments present a further problems of safe disposal.

Management

Both the federal Fisheries Act and the provincial Waste Management Act can be invoked to control or regulate discharges from ship-building, repair, and maintenance operations. Currently, the federal Department of the Environment, Department of Fisheries and Oceans, and the provincial Ministry of Environment are developing Best Environmental Management Practices for 10 major shipyards in B.C. While these are aimed at the major shipyards, it is hoped that smaller shipyards will observe them as well. The proposed practices include:

- Spent grit and other debris should be removed from the dry dock prior to flooding or submerging
- Spent grit and paint debris should be kept clear of water drains, or drains should be designed to prevent the entry of spent abrasives and debris
- Paints, solvents, and degreasers should be stored on curbed concrete pads or when stored in buildings the floor under the storage area should have curbs to contain spills
- Bulk liquid storage tanks should be mounted in diked areas or on curbed concrete pads designed to contain the full holding capacity of the tanks within the area
- Abrasive blasting and painting operations should be prohibited when carried out over water unless proper precautions are taken to prevent the entry of these materials to the receiving waters
- New and spent abrasives should be stored in a manner that will prevent their entry or the entry of leachates from the storage area into receiving waters
- Each operator should prepare a spill contingency and clean-up plan appropriate to the facility

- The disposal of spent abrasives should be in accordance with approvals of the local government agency having jurisdiction

- Dust emissions from abrasive blasting operations should be minimized by using low friability/low dusting abrasives. At no time should the opacity of the dust cloud exceed 20% on the Ringelman scale

- Painting operations should not be carried out when prevailing winds may cause spray drift onto nearby properties

Actions Required

Action required for ship building and repair facilities include:

- Awareness regarding the best management guidelines

- Investigation of other control alternates: siting - locating away from sensitive biological areas, and in areas with high flushing; and design - to maximize flushing and provide for waste collection

Log Handling Debris and Leachates

Nature and Magnitude of the Problem

The Fraser River estuary is an important log handling area for the B.C. coastal forest industry. Forty processing operations are located in the estuary, consuming 25% of coastal timber production, employing 9,400 people at an annual payroll of over $260 million, and generating final product sales of $650 million (1984) (Log Management Activity Workgroup, 1989). Logs are stored in the river for mill supply and for protection against marine borers. The Log Management Activity Workgroup determined that the freshwater storage space leased in the estuary, 3,217 ha of the estuarine area, is sufficient for current needs.

The Log Management Activity Workgroup identified debris control as a management issue needing clarification and study. Log abrasion, bark removal, and debris deposition occurs during towing, barge dumping, bundle breaking, sorting, and storage. Debris smothers benthic organisms and habitat. Decaying debris may result in oxygen depletion or hydrogen sulfide production. Leachates are released from freshly cut logs.

Management

The North Fraser Harbour Commission requires operations in its jurisdiction to collect, contain, or remove floating debris at their sites. Approximately 21,400 m^3 of debris is burned annually at the Commission's disposal site. The Fraser River Harbour Commission does not have an equivalent program. The B.C. Debris Control Board operates a debris trap and disposal site near Agassiz. The trap disposes of over 90,000 m^3 of debris annually. Most of this is natural debris that would otherwise be carried into the lower Fraser and the Strait of Georgia.

There are no guidelines on how logs may be dumped to stored to minimize debris creation, though conditions or restrictions may be attached to the log storage water lot lease. There are guidelines for review of coastal log handling applications (MLPH, 1982).

Estuary-specific guidelines are needed to minimize debris creation and the associated impacts. The Log Management Activity Workgroup has submitted recommendations to alleviate impacts from log handling. These include:

- FREMP should work with the B.C. Debris Control Board and other controlling agencies to provide debris control in uncontrolled areas
- Collection and disposal methods should continue to be developed and used at barge dumping sites, log dumps, raft-building sites, and mill side handling zones to control bark and wood debris
- Accumulation of bark and other debris on land and docks around mill sites should be kept out of the water and removed to land fill or other sites at regular intervals
- The violent, free-fall dumping of logs into the river should be discouraged because it is a major cause of loose bark and other debris
- Industry should consider the use of bag-booms to corral debris generated from barge dumping

Actions Required

Log handling actions required include:

- Implement the Log Management Activity Program

- Monitoring to determine leachate toxicity adjacent to log booms. As flushing varies by site, do storage grounds need to be prioritized to minimize leachate impacts?

- Develop Guidelines or Codes of Practice for Log Handling in the estuary

Dredging

Nature and Magnitude of the Problem

The Fraser is naturally a sediment laden river. An average 17.3 million tonnes is transported annually past Mission. About 3 million tonnes of this is deposited in the Fraser estuary and delta annually, advancing the delta front (measured at the -90 m bathymetric) by 4.5 m and the mouth of the Main Arm by 8.6 m per year on average (Stewart and Tassone, 1989). Most sediment transport occurs during spring freshet as sediment load is dependant on water volume and velocity. About 660,000 tonnes per day is transported during freshet (Drinnan and Clark, 1980) An average of 7.3 million tonnes of sediment is dredged from the river channel every year, resulting in a net deepening of the channel. Anthropogentic sediment inputs, from municipal, industrial, and stormwater discharges, total 32,000 tonnes per year (WMAP, 1990).

Most chemical pollutants have a strong affinity for particulate matter. Over 90% of hydrocarbons, for example, may be deposited in estuarine sediments (Goyette and Boyd, 1989). These contaminants are either absorbed (go into the particle like water into a sponge) or adsorbed (bind to the surface of a particle like a magnet on a refrigerator). Complex organics such as PCBs and PAHs are virtually insoluble in water but will bind to sediment particles containing organic carbon. Many organic substances will bind to clay particles. Metals and other contaminants may be discharged in particulate form, or adsorbed to suspended solids in the discharge. Metals such as lead and cadmium that are discharged in dissolved form bind to suspended particles and accumulate in sediment. Some metals, and polar organic substances such as phenols, find a balance between dissolved and adsorbed forms depending on pH, salinity, temperature, and other factors. Substances can be removed from the water column by the addition of sediments that take up the substances and settle out. Thus, bottom sediments near where contaminants are discharged may accumulate toxics.

Annual dredging is required to maintain shipping channels in the river. Periodic dredging is also required to maintain depths in shipping berths and sawmill sorting ponds. New dock construction, or requirements for fill material, may require that sediments be excavated. Clean dredgate is routinely dumped in deep water, at dump sites on the outer estuary at Sandheads and Point Grey, or used as on-shore fill. If the sediments to be dredged are

contaminated, however, handling and disposal becomes more complex; this is the contaminated sediment problem.

Sediment monitoring programs include the FRES review (Stancil, 1980), some Westwater Research Centre sampling (Hall et al.,1974), a 1985 program (Swain, 1986), the Fraser River Harbour Commission/MOE program that sampled Fraser River sediments in 1987 (Swain and Walton, 1988) and Boundary Bay sediments in 1989 (Swain and Walton, In Prep). The 1990 NFHC/MOE program is examining contaminants and particle size on the outer estuary. A number of other special projects have sampled sediments (see Standing Committee on Fraser River Water Quality, 1987; 1988; 1989). Of related interest is the study of benthic contaminants in Vancouver Harbour during 1985 - 1987 (Goyette and Boyd, 1989).

For the Fraser River, results from the 1987 program are that PCBs and chlorophenols could not be detected at the replicate sites. The 1985 program did detect these at some sites, the difference may be related to a coarser particle size in 1987 or reduced releases. PCBs were detected at a random North Arm site at a level exceeding water quality objectives. Chlorophenols were detected at some random 1987 sites, but at values less than the water quality objectives. For other contaminants, 1987 values were generally lowest in the Main Stem, higher in the North Arm, and highest in the Main Arm; the same trend was apparent in 1985. Measured characteristics were usually lower in 1987 than 1985, probably due to the coarser 1987 particle size. Values of zinc and lead appear highest in the North Arm, probably due to stormwater inputs. The 1987 tributary monitoring program indicated contaminant problems from cadmium, copper, lead, mercury, tin, and zinc in Still Creek sediments, and lead, mercury, and zinc in Brunette River sediments (Swain and Walton, 1988).

Few projects have attempted to determine where "hotspots" of contaminated sediments exist in the estuary. One is a report prepared by the Richmond Health Department that catalogues 81 industrial sites in Richmond that are potentially hazardous due to toxic wastes.

Management

Environment Canada approval, under terms of Ocean Dumping Regulations of the Canadian Environmental Protection Act, is required for dredge spoil disposal in the tidal reaches of the Fraser River. Public Works Canada holds several ocean dumping permits for in-river disposal sites and sites at Point Grey and Sand Heads. The Canadian Environmental Protection Act requires that contaminants in dumped dredge spoil be below certain levels. Generally there is no problem with material deposited as part of the natural sediment load.

The Regional Ocean Dumping Advisory Committee (RODAC) considers ocean dumping requests.

Interim Contaminant Testing Guidelines for Ocean Disposal have been developed by Environment Canada. The guidelines show interim screening and rejection limits for various contaminants.

The Navigation and Dredging Activity Program Work Group (1990) considers some elements of contaminated sediment dredging.

Actions Required

- Implement the Navigation and Dredging Activity Program Plan elements related to contaminated sediments
- Review guidelines for sediment contaminants testing and disposal

Oil and Chemical Spills

Nature and Magnitude of the Problem

Ammoniacal copper arsenate (ACA), chromated copper arsenate (CCA), and pentachlorophenol (PCP) are all used by lumber mills on the estuary to preserve wood. ACA and CCA processes involve dilution with water, PCP is dissolved in oil before application. Spills can occur at several stages including delivery, on-site storage, chemical mixing, solution storage, and treatment stages. Ammonia, copper, chromium, arsenic, chlorophenols, and oil can be released at any of these stages.

Management

The federal Transportation of Dangerous Goods Act (RSC 1985 Ch. T-19) and its regulations are administered by Transport Canada and has also been adopted as provincial legislation administered by the Ministry of Transportation and Highways (SBC 1985 Chap. 17). Major requirements include reporting of accidents, including spills, that represent a danger to health, property, or the environment and involve at least 5 kg or 5 L of poisonous substances or at least 1 kg of substances hazardous to the environment.

The Migratory Birds Convention Act (RSC 1985 Ch. M-7), administered by the Canadian Wildlife Service, prohibits the release of oil or any other substance harmful to migratory birds into waters or areas frequented by migratory birds.

The Canada Shipping Act (RSC 1985 Ch. S-9), administered by Transport Canada, prohibits the discharge of oil, oily bilge waters, and other noxious substances by ships and commercial water craft. The pollution prevention and control provisions of the act were extensively revised in 1987 (RSC 1985 Ch. 6 (3rd Supp.)).

Recently, a Spill Reporting Regulation (B.C. Reg. 263/90) to the provincial Waste Management Act has been enacted. Requirements are that a person with possession of substance before its spill, or a person observing the spill, should immediately report the spill to the Provincial Emergency Program or the local police. Substances are as listed in the federal Transportation of Dangerous Goods Act and its regulation, and the amount of the substance that constitutes a spill is given in a schedule to the Spill Reporting Regulation. Addition powers for clean-up are provided in the Environmental Management Act (SBC Ch. 14). Where the minister considers that an environmental emergency exists, he may order that appropriate measures be taken.

The Provincial Emergency Program is a department in the Ministry of the Solicitor-General. It is responsible for coordinating responses to environmental emergencies such as floods, storms, evacuation from forest fires, earthquakes, and dangerous chemical spills. PEP does not have its own equipment or communications system, instead, its 30 staff recruit and coordinate civic employees from other municipal and provincial sources as they are required.

The FREMP Emergency Response Activity Program has evaluated oil and chemical spill response procedures in the estuary.

Actions Required

- Implement Emergency Response Activity Program

Landfilling

Nature and Magnitude of the Problem

Solid waste generated in the region is deposited in landfills that can be classed as municipal landfills, industrial landfills, industrial refuse sites, and wood waste landfills. Municipal landfills accept mostly domestic wastes and some construction or demolition

debris. Industrial landfills generally accept "inert" construction and demolition debris. Industrial refuse sites are usually associated with an adjoining industry and accept foundry wastes, metal scraps, sand, ash, gravel, broken pottery, and other such wastes. Wood waste is used as a fill base in areas of boggy or compressible soils.

All landfills generate leachates when exposed to water infiltration. In the moist climate of the Fraser River estuary region, water infiltration of landfills is almost certain. Groundwater contamination problems can then result.

Surface water contamination also results from infiltration through landfills and refuse dumps. Many landfills in the area are placed on peat bogs that compress under the weight of the fill, causing a reduction in peat permeability (Atwater, 1979). Consequently, a lateral flow system generally distinct from the groundwater flow system results, and leachate impacts are directed more to surface waters in surrounding ditches and streams. Subsurface leachate losses are probably minor compared to ditch and stream discharges. At the same time, lateral flows allow capture of almost all landfill seepage given a suitable collection system. Landfills located on impermeable clay layers also have lateral flows.

Virtually all waterbodies in the Fraser River estuary area have been subjected to wood waste leachate discharges.

Richmond landfill treated effluent is discharged to the No. 7 Road Canal, which in turn enters the Main Arm. Fish kills have occurred in the canal. The treatment system has not reduced ammonia values to acceptable levels in some winter periods.

Management

All landfills require a Ministry of Environment Waste Management permit, though reasonable use of wood waste is exempt. A Letter of Exemption may still be required for wood waste.

Leachates from the Port Mann, Burns Bog, Kerr Road, Braid Street, and Cottonwood municipal landfills are collected and discharged to the Annacis Island Sewage Treatment Plant.

More landfill information is presented in the Groundwater Contamination Discussion Paper (Hagen, 1990).

Actions Required

Actions required to reduce discharges and impacts from landfills include:

- Enhance awareness of operating guidelines and codes of best management practice for landfills. In some cases, pollution control objectives should be reviewed
- Encourage Reuse, Reduction, and Recycling initiatives to reduce the amount of landfilled material
- Reduce amount of leachate escaping to the environment by (1) reducing amount of material deposited in landfills, (2) reducing water infiltration, and (3) capturing leachate for treatment
- Determine captured/not captured leachate ratio. The proportion of generated leachates that are captured and treated for the landfill affected is not well known.
- Monitor and evaluate leachate quantity, quality, and toxicity at industrial refuse sites, including closed or completed fill sites. Estimate leachate generated. Inventory and prioritize sites in terms of impacts
- For wood waste: develop and adopt standards for discharge from wood waste fill sites; reconsider the widespread use of Class C letters of exemption; consider the use of municipal bylaws to control wood waste use

Illegal dumping

Nature and Magnitude of the Problem

Illegal, or convenience, dumping is done by individuals or contractors who don't know where a landfill is, don't care to travel there, or don't want to pay the tipping fee. The result is random dumps of garbage or debris in out-of-the-way places. These range up to several truck loads in size. In a brief survey, Atwater (1980) found numerous such sites along the Fraser River.

Impacts are primarily aesthetic, but toxic effects may result from toxic or hazardous wastes dumped next to a ditch, stream, or river.

Management

Dumping is illegal under the Waste Management Act.s. 3 and s. 6, though s.6 is not in force. Anyone who contravenes s. 3 is liable to a penalty not exceeding $1,000,000. The Litter Act (RSBC 1979 Chap. 239) regulates some aspects of dumping. All municipalities have bylaws prohibiting dumping.

Enforcement is through surveillance by police, conservation officers, FRHC and NFHC harbor patrols, and similar public employees. Response is made to citizen complaints, but little action is possible unless evidence such as a licence plate number is provided.

Actions Required

Actions required include:

- Enhance surveillance, develop more effective enforcement/surveillance procedures
- Public awareness is not a factor as most people know dumping is illegal, but programs to encourage citizen surveillance may be effective
- Investigate incentives to encourage proper waste disposal

Flooding and Soil Erosion

Nature and Magnitude of the Problem

Flooding may be annual freshet flooding, occasional natural flooding due to heavy precipitation or runoff, and purposeful flooding as during cranberry harvesting or reservoir lowering.

The Fraser River estuary is protected by dykes intended to withstand a one-in-200 year flood, equivalent to the floods of 1894 and 1948. Because of this, freshet flooding does not pose any waste management concerns. Clean sediments deposited in sloughs and sidechannels during freshet may bury sediments higher in contaminant concentration, reducing biological availability of the contaminants.

Periods of heavy precipitation, especially during October to April, may result in localized flooding. Urbanization and land clearing increases storm runoff volume and results in a higher and more rapid peak discharge, exacerbating flood risks. Waste management concerns from this type of flooding are the animal mortalities that may result, the washing

into streams of agriculture wastes spread on fields, and increased soil erosion. The Serpentine and Nicomekl lowlands are particularly susceptible, frequency is about 2 - 3 times per year.

A similar kind of flooding may result when B.C. Hydro releases water from Alouette Lake, which is dammed to act as a reservoir for water diverted to the Stave Lake system power houses. Water levels may rise dramatically on the Alouette River, with little warning.

Cranberries are harvested during October-November by flooding fields with river water, and collecting the floating berries. The water is then discharged back into the river. Wood waste berms are used to keep the water on the fields, and wood waste is used for field access roads. Waste management concerns lie in the amount of wood waste leachate and pesticide residue in the water returned to the river. Cranberry farms are concentrated along the North Arm, with a few on the Nicomekl and Alouette Rivers.

Soil erosion occurs with runoff and peaks during flooding. From a waste management perspective, soil erosion has two potential contaminant problems. One is the presence of soil particles in water as sediments. These increase turbidity, decrease light penetration in the water, adversely affect photosynthesis, and affect predator/prey relations through impacts on visibility. When sediments settle out, they may smother bottom vegetation, fish habitat, and fish eggs. The second potential problem is the introduction of contaminants that are adsorbed to the soil particle. Nutrients such as phosphorus and pesticides such as DDT and parathion readily adsorb to soils and are relatively immobile unless the soil is moved.

Management

The FREMP Implementation Strategy (FREMP Review Committee, 1984) provided for a Dyking and Drainage Activity Program which has not been implemented.

The federal-provincial Fraser River Flood Control Program oversees construction and completion of dykes, bank protection, and internal drainage necessary to prevent major flood damage.

Agriculture Canada and the B.C. Ministry of Agriculture and Fisheries sponsor soil conservation programs, soil management plans, and the Agricultural Land Development Assistance program.

Actions Required

Actions required include:

- Continued initiatives to reduce flooding and soil erosion
- Monitor a cranberry operation to determine magnitude of wood waste leachate and pesticide residue problem

Atmospheric Deposition

Nature and Magnitude of the Problem

The main concern about atmospheric deposition is as a contribution to stormwater contamination. Both Swain (1983) and Lawson et al. (1985) found significant contaminant contributions from dustfall, with lesser contributions from precipitation. For a residential basin, copper, ammonia, nitrate/nitrite, organic nitrogen, manganese, and zinc concentrations were higher in stormwater than in the Fraser River (Swain, 1983). Dustfall directly onto surface waters is a very small contribution to overall contaminant loadings, but little is known about dustfall contributions to toxicity in the surface microlayer.

The Greater Vancouver Regional District ambient air quality monitoring network monitors gaseous and particulate contaminants. Gaseous pollutant monitoring includes sulphur dioxide, nitrogen oxides, carbon monoxide, and ozone. Sulphur and nitrogen dioxide are implicated in the creation of acid rain, but there is no known correlation between measured SO_2 and NO_2 concentrations and the acidity of local rainfall Particulate pollutants may settle or be washed out of the atmosphere. Those monitored by the GVRD include suspended particulate, suspended particulate metals, suspended particulate lead, dustfall, and coefficient of haze.

GVRD monitoring results for suspended particulates show similar annual geometric mean values during 1986 to 1989 at most stations, but a decreasing trend is evident since 1978 (GVRD, 1988; 1989). In 1989, the Level A annual air quality objective of 60 ug/m^3 geometric mean was exceeded at two stations, Fraser Mills (65 ug/m^3) and East Burnaby (64 ug/m^3). The Level B 24 hour objective of 120 ug/m^3 average concentration was exceeded in 35 of 2,225 samples taken, most of these at stations near the Fraser River.

Lead is the only particulate metal air pollutant with ambient levels high enough to be a potential problem in typical urban settings (GVRD, 1989). Other metals monitored by the GVRD

are cadmium, chromium, copper, manganese, nickel, and zinc. In 1989, suspended particulate metal levels were similar to or slightly lower than 1988, continuing a recent trend. Since 1978 a substantial decrease has occurred in lead levels as a result of the decreased use of lead gasoline. The 1989 annual geometric mean for lead was one-tenth or less of the Level A 2 ug/m^3 air quality monitoring objective at all stations.

Dustfall is a measure of the amount of particulate matter that settles out of the atmosphere or is washed from the air by rainfall. Much particulate material monitored as suspended particulates will eventually settle or be washed to the ground to become dustfall. Annual mean dustfall in 1989 ranged from 0.4 mg/dm^2/day to 1.0 mg/dm^2/day at the 17 GVRD stations with dustfall samplers, and was generally slightly lower than 1986, 1987, and 1988 values. There are no national air quality guidelines for dustfall. The provincial interim desirable level of 1.75 mg/dm^2/day was exceeded at 3 stations in 1989.

Management

The Waste Management Act Section 19 authorizes the GVRD to control air emissions in the region, the Waste Management Branch of the Ministry of Environment is responsible for air emission outside of the GVRD. Emissions are regulated through a permit system which sets out conditions for emission quality, monitoring, and reporting.

Ambient air quality in the lower Fraser Valley is monitored by 190 samplers at 47 Greater Vancouver Regional District stations in 14 communities and by 3 Ministry of Environment stations at Pitt Meadows, Abbotsford, and Chilliwack. Air quality is evaluated according to a set of objectives established by Environment Canada under the Canadian Environmental Protection Act (formerly under the Clean Air Act), which define Maximum Desirable, Maximum Acceptable, and Maximum Tolerable contaminant concentration levels. The B.C. Ministry of Environment has also established ambient air quality objectives, which are generally similar to the federal objectives. Provincial air quality criteria and objectives are currently under review.

In the summer of 1988 the GVRD initiated an Air Management Plan. Stage 1 of the plan, an assessment of current and future air quality issues and regional air quality trends, was completed in September 1989. The assessment is based on historical monitoring data and a detailed inventory of 1985 emissions. The Stage 1 Plan makes several recommendations in the areas of air quality monitoring, modeling, emission inventory, and ongoing air management planning.

Vancouver City Council created a Task Force on Atmospheric Change which submitted a final report that was adopted by council in November 1990. Some proposed activities will have the effect of reducing particulate emissions, including curtailment of private vehicle use, emission testing and controls, and restrictions on wood burning and incineration.

Federal and provincial initiatives regarding air quality which will affect water quality in the Fraser River estuary include the elimination of lead from gasoline by December, 1991.

Actions Required

Actions required include:

- Investigate the relationship between air pollution and stormwater contamination. Efforts to curb air emissions should take into consideration the impact of emissions on water as well as air quality

Contaminants Entering the Estuary from Upstream Sources

Nature and Magnitude of the Problem

Contaminants entering the Fraser River upstream of Kanaka Creek and brought into the estuary may be from natural or man-made sources. Contaminants from natural sources include oxygen demanding substances, pathogens, nutrients, sediments, metals which bind to sediments or are present in dissolved form, and possibly PAHs contributed by forest fires. Estuarine biota have adapted to normal contaminant levels, even where these are relatively high. Impacts from man-made source contaminants, even where apparently small relative to amounts already present, cannot be ruled out, because the characteristics of man-made and natural contaminants may differ.

Man-made contaminant discharges to the Fraser system outside the estuary include municipal wastes, primarily in the Lower Fraser Basin, at Kamloops, and at Prince George; pulp mill effluents at Kamloops, Quesnel, and Prince George; mining wastes; potentially contaminated runoff from sawmills and other industries using wood preservatives; and runoff from dispersed areas of agriculture and silviculture. For the Fraser basin above the estuary, authorized 1985 municipal discharges totalled 190,300 m^3/day and industrial discharges were 643,900 m^3/day (Servizi, 1989).

The major industrial effluent sources upstream of the estuary are the six pulp and paper mills at Kamloops, Quesnel, and Prince George, with a total pulp production averaging over

5,700 air dry tonnes per day. These mills account for over 90% of the industrial effluents discharged upstream of the estuary. Five of these mills produce bleached kraft pulp, and treat their effluent in aerated lagoons with 4.5 to 8 day retentions. The sixth mill is Quesnel River Pulp's chemi-thermomechanical plant. Their effluent is also secondary treated with retention in an aerated lagoon. Contaminants of concern discharged by the pulp mills are chlorinated phenolics, including chlorophenols, chloroguaicols, chlorocatechols, and chlorovanillins; chlorinated benzenes, the dioxins and furans; and resin acids. Using the data of Carey and Hart (1988), Carey (1990) indicates a chloroguaiacol loading to the estuary of 26 - 45 kg/day.

Forestry activities take place in several Fraser River system watersheds upstream of Hope. Contaminants identified with forest activities include sediment, elevated temperature, pesticide residues, and organic debris. All these could be expected to have local impacts, and are addressed through Best Forest Management Practices. Impacts on the estuary are unknown.

Monitoring is necessary to determine the amounts of contaminants entering the estuary. While some sporadic monitoring has occurred lower down, the lowest regularly monitored station is the federal-provincial station at Hope. This station has monitored a number of parameters, but the data have never been summarized.

Management

Pulp and paper mill emissions are regulated by provincial permits issued under the Waste Management Act with guidance for permit writers from the Pollution Control Objectives for the Forest Products Industry of British Columbia (MOE, 1977). Draft regulations to install secondary treatment facilities, reduce chlorinated organic compounds (AOX) discharges to 2.5 kg per tonne of pulp production by the end of 1991, and to 1.5 kg by the end of 1994 were produced during 1989 and referred to the B.C. Round Table on Environment and Economy. In December 1990, the Pulp Mill and Pulp and Paper Mill Liquid Effluent Control Regulation (B.C. Reg. 470/90) was issued that set AOX discharge standards of 2.5 kg per tonne of pulp production by deadlines individually taylored to each mill. The Prince George and Quesnel mills have a 31 December 1991 deadline, the Weyerhauser Mill in Kamloops has a 31 December 1993 deadline. A 1.5 kg standard has not been regulated, and has been referred for more technical study.

The mills are also covered by the water pollution prohibition section of the federal Fisheries Act and the Pulp and Paper Effluent Regulation (1971) under that act. Amendments to strengthen the regulation and extend it to mills currently enjoying exemptions are being

prepared. New regulations under the Canadian Environmental Protection Act to virtually eliminate dioxins and furans, and to reduce organochlorines, are also being prepared.

Actions Required

Actions required include:

- Enhance water quality monitoring at Hope or establish a water quality monitoring station at Mission or other location representative of water entering the estuary
- Analyze water quality data collected at Hope

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